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Micro-scale effects over the wind: modelling flow around buildings with WindSim-Phoenics

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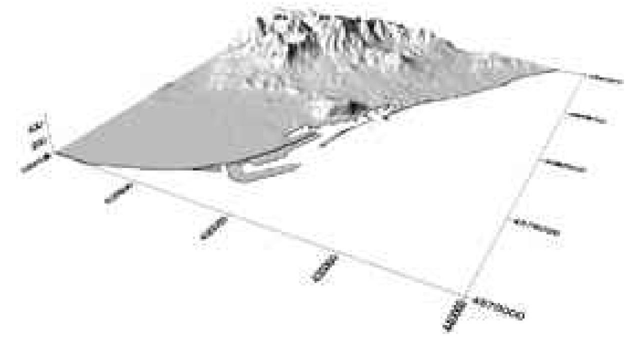
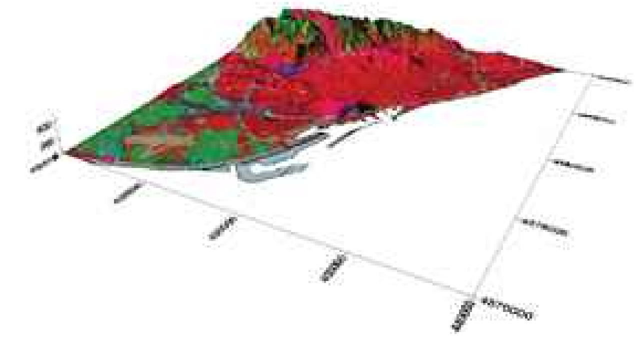
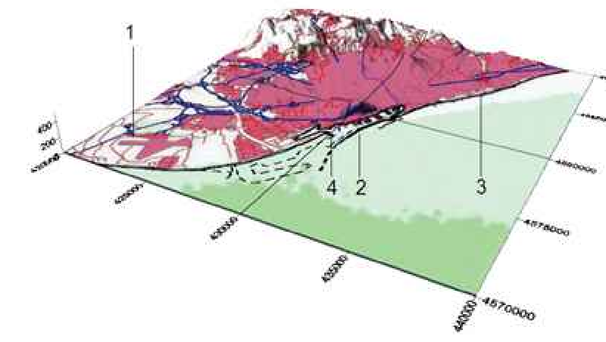
Photomontage



Elevation

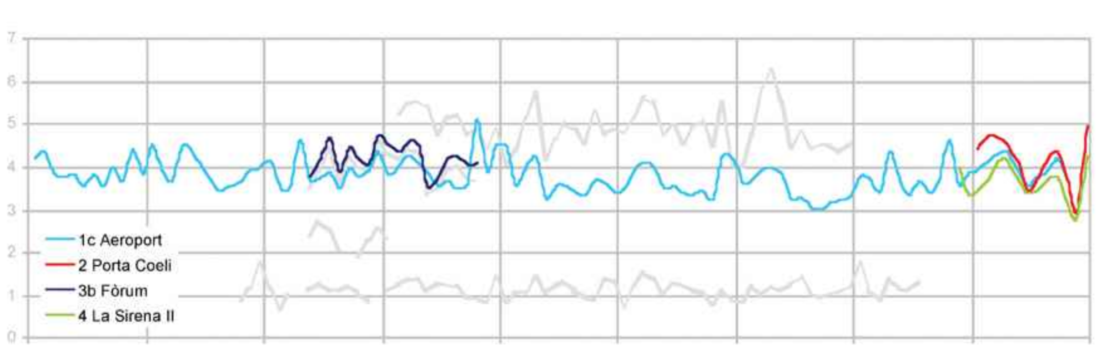


Land-Uses

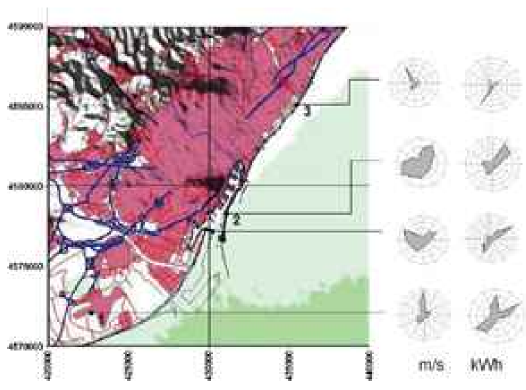


Measurements

The aim of this project is the estimation of the wind resource on a future enlargement of the Barcelona harbor. The area of study is not very complex under the point of view of the **topography** (according to the 20x20km^2, 3"arc resolution SRTM data) but very heterogeneous regarding the **roughness** of the terrain due to the vicinity of the city and suburbs. In order to achieve reliable results for the study, an exhaustive research of **local wind data sources** was performed. After the usual analysis, only four of these sources (located in the picture) remained after the quality control: 1. Airport, 2. Porta Coeli, 3. Fòrum & 4. La Sirena II

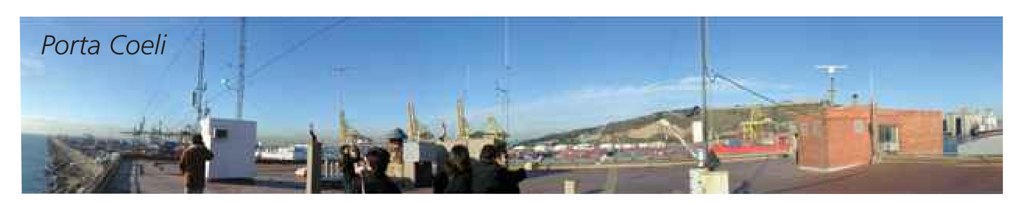


Time Series



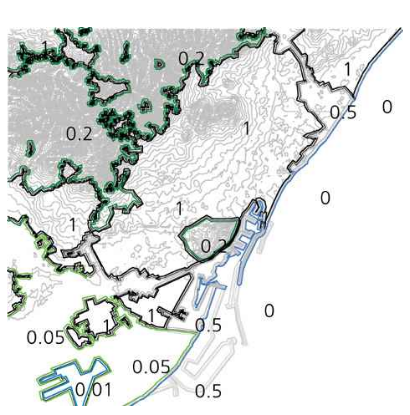
Wind&Energy Roses

Porta Coeli

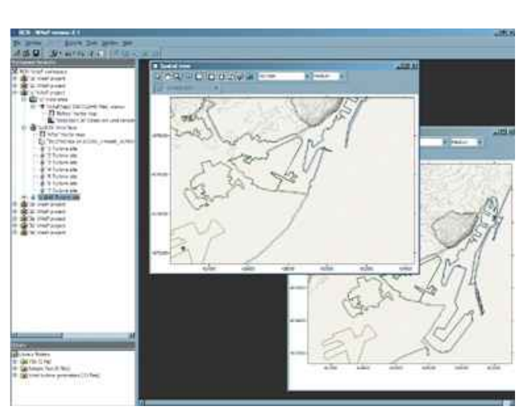


La Sirena II

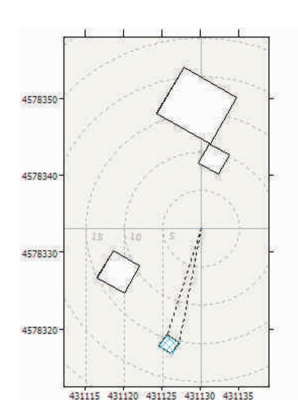
Despite of the large differences in installation, exposure and measurement periods among the various data sources there is a remarkable **coherence** among them regarding both the directional regime (clearer in the energy rose) and the seasonal variation. Since the scenario can be described as non-complex topography, the standard package **WAsP** was used for the wind field modeling. Measurements from mast #2 (Porta Coeli) were used for its application because of their proximity to the proposed turbine locations and the quality of the installed sensors. Unfortunately, that mast was placed on the **roof** of a building.



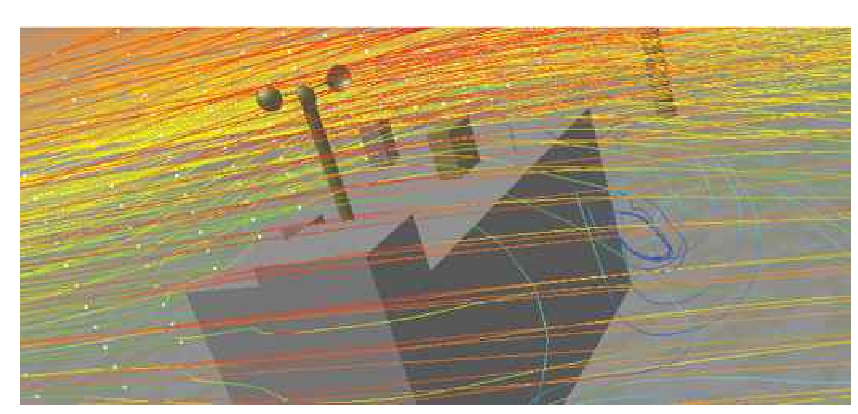
Roughness

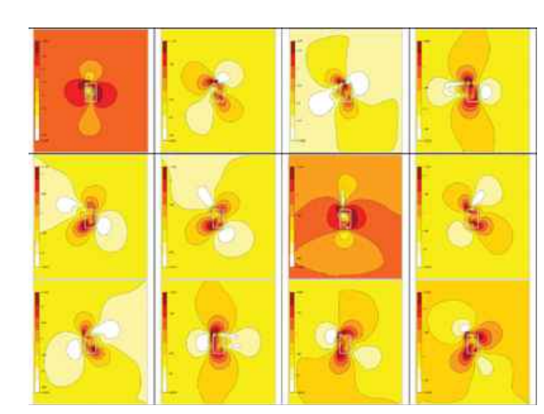


Double Map



Obstacles





Special care was taken on two aspects during the modeling process: the **roughness** complexity of the landscape and the presence of **obstacles**. For the first one, a detailed double map (with the new dock for the Application and without it for the Analysis) was used. Such a scheme was needed since the geometry of the harbor in the moment of the hypothetical turbine placement will be different than the one that existed during the measurement period.

For the obstacles problem, two strategies were performed: the first one was to consider the influence of the building within **WAsP** following *Landberg (2000)*, who suggests to create an artificial topography around the building with slope 1:5, and to use the obstacle model of *Perera (1981)* afterwards to consider the effect of the small constructions located on the roof.

The second strategy was to make use of the CFD-based software **WindSim** to evaluate the effects on the flow of both the building and obstacles simultaneously.

As advanced users of WindSim, we worked directly on the files that WindSim transfers to **Phoenics**, which is the CFD solver that comes with WindSim. A limitation here is that the building had to be described upon the numerical grid geometry. That is, the way we found to simulate obstacles was setting some grid cells as solid (i.e., not allowing for flow inside them). Nevertheless, since we worked on a quite fine grid, we were able to reproduce the complete building+obstacles geometry with great detail.

WindSim-Phoenics showed its ability to resolve the non-linear effects caused by solid obstacles within the flow. Specifically, **recirculation** was obtained close to downwind walls. This is shown on the above streamline figures. Similarly, an acceleration-deceleration (depending of the incoming wind direction) of the flow above the building was also obtained.

To evaluate the reliability of the approximations made, the measurements from the nearby Site #4 (La Sirena II) were used for a cross-check that could not be very accurate due to the poor characteristics of the site and installed sensors.

Comparing to this additional data source, the WindSim-Phoenics method resulted in a better agreement than the classical one. Discrepancies in energy production are of the order of 35% and 4% for the classical and the WindSim-Phoenics method respectively.

In conclusion, for this particular case results from WindSim-Phoenics method seem to perform better than the classical method. Such results show that the effect of the building in modifying the flow was quite **small**, contrarily to what we previously thought. A reason for this minor effect may be that the anemometer and the vane where placed high enough above the building (i.e., 10 m respect the building height of 20 m).

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